
Teddy Llovet

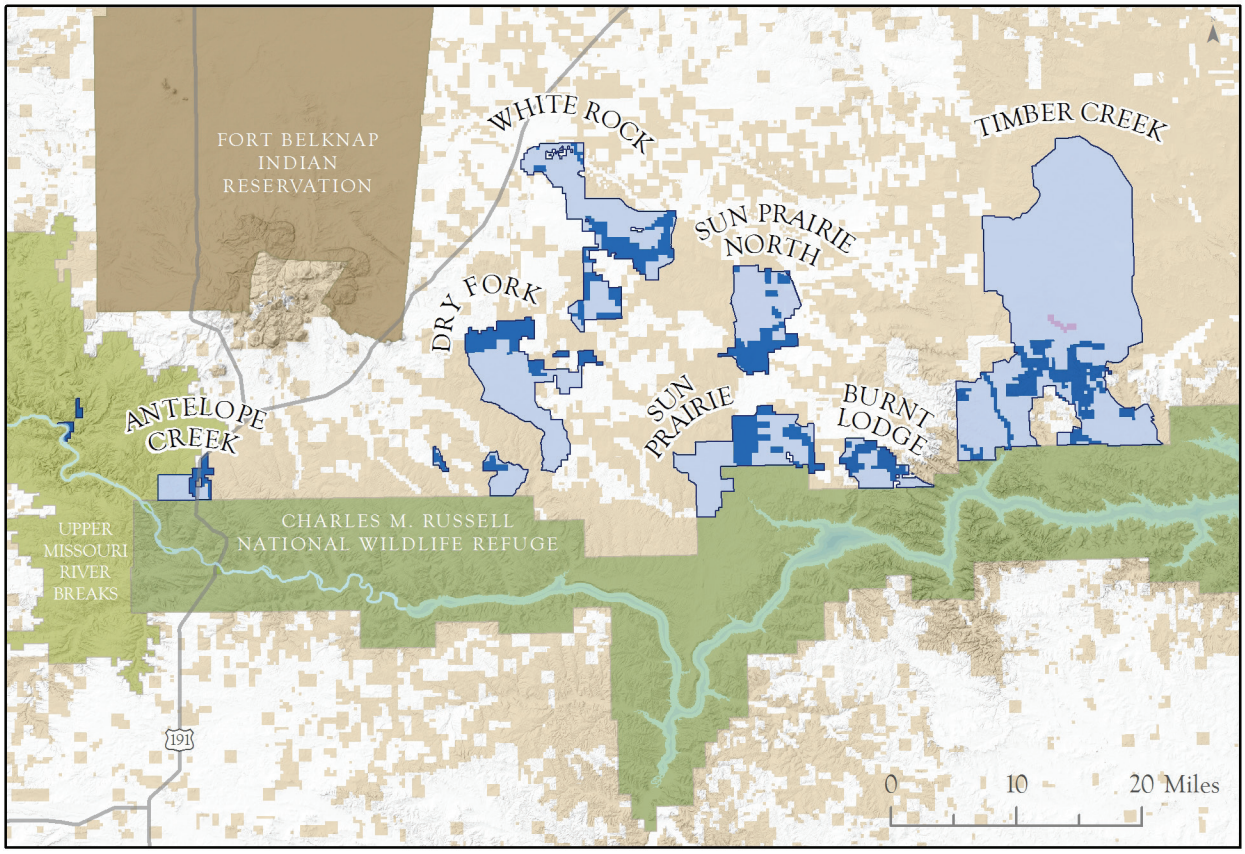
AMERICAN PRAIRIE RESERVE

Freese Scale for Grassland Biodiversity

Background Summary

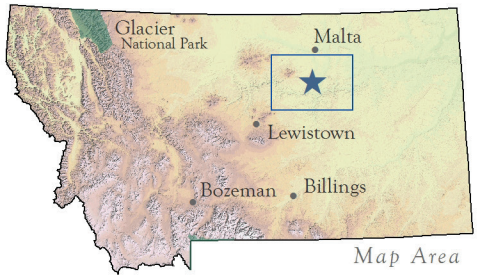

Dennis Linghor


Diane Hargreaves



American Prairie Reserve: Current Extent

- APR Deeded
- APR Leased
- Option to Purchase
- Public Land
- National Wildlife Refuge
- National Monument
- Indian Reservation
- Private Land



Contents

Introduction

The overarching goal of American Prairie Reserve (APR) is to restore and conserve the biodiversity—species, habitats and ecological processes—that was native to this region for the past several thousand years. In doing so, we recognize that the prairie ecosystem is a highly dynamic place and that species, habitats and ecological processes vary and shift across the land over time. Thus, our goal is not to restore biodiversity to some predetermined, unchanging condition. Rather, our goal is to restore the natural ecological conditions that are most important for maintaining a fully functioning, self-sustaining ecosystem endowed with the diversity of life the region once harbored. As has been the case for millennia, humans will be part of this ecosystem but not in the command-and-control manner that prevails over most of our lands.

The focus on ecological conditions is not so different from the often-used cinematic metaphor "build it and they will come." Ecological conditions are like the baseball diamond, equipment and rules of the game. Once they are in place, the players (species) and action of the game (ecological processes) will return. The score will change over time and different players will dominate, just as species populations and ecosystems fluctuate. This, however, is where the metaphor ends, because the ecological game never ends and is endlessly fascinating.

Livestock ranching (mostly cattle) and, to a lesser degree, dry-land farming (mostly grain) are major land uses among private, tribal and public landowners in the region. For this reason, we have focused on how these commodity production activities affect ecological conditions and biodiversity.

To help guide our actions over time, we have developed a scale that evaluates land management based on ten ecological conditions that have been most affected by human activities, particularly commodity production (livestock and grain), on lands in the APR region. Each condition is measured on a 7-point scale arranged along a continuum. At one end is commodity management, which describes activities like grain or cattle production that are common in the APR region and that have substantially altered ecological conditions. At the other end of the continuum is biodiversity management, which represents ecological conditions that should be in place when biodiversity conservation is the primary goal for the land.

The result is a scale that tracks the effects of different management decisions on ecological conditions, providing APR with a tool to assess our progress as we transition lands from a primary focus on livestock and grain production to a focus on biodiversity.

We want to emphasize that not all commodity producers operate at the far end of the continuum away from conservation. In fact, most in the APR region are well aware of many biodiversity values of their land and take measures to conserve native prairie and much of its wildlife. Moreover, human infrastructure such as power lines and roads are not solely due to commodity production needs, but they do impact important ecological conditions. We therefore also incorporate these concerns where appropriate in the scale.

The ten ecological conditions are largely based on a paper (in review for publication) by Curtis Freese, Samuel Fuhlendorf and Kyran Kunkel titled "A Management Framework for the Transition from Livestock Production toward Biodiversity Conservation on Great Plains Rangelands." We have also drawn on other sources of information and ideas to tailor the scale to the particular ecological and land management conditions of the American Prairie Reserve region.

In this document, we will introduce each ecological condition with a broad overview. All ten conditions are common to much of the Great Plains as well as to grassland and savanna ecosystems throughout western North America and elsewhere in the world. We then zoom in to describe the importance of each ecological condition in the APR region and how common commodity management practices and other development activities in the region alter that condition. A comment about APR's management response concludes each description.

For the sake of brevity, we do not describe the many important collaborators involved in research and management activities on APR owned and leased lands. These are described elsewhere on our website.

1. Prairie Vegetation

North America's prairies—and grasslands around the world—are characterized by hundreds of species of plants belonging to three major groups:

1. grasses, narrow-leafed plants that grow from the base, including "true" grasses, sedges and rushes;
2. forbs, non-woody plants with often broader leaves and showier flowers than grasses have; and
3. woody plants, ranging from shrubs to trees.

Soil conditions, history of grazing and fire, and many other factors determine which species of plants grow in any one area. As these conditions change from one side of a hill to another, from dry uplands to wet bottom lands, and so on, the species of plants also change, resulting in a rich diversity of plant communities, or habitats.

All plant species are not of equal value as forage for livestock. Thus, rangeland managers often aim to increase the growth of plant species that are highly nutritious for livestock and suppress those that are not. This results in a more uniform plant cover across the landscape rather than the mosaic of plant communities found under natural conditions. In turn, there is a decline in the diversity of insects, birds and mammals.

Three general methods are employed to increase the production of favored forage species: (1) alter soil conditions by, for example, furrowing, fertilizing and irrigation; (2) remove or suppress undesirable vegetation by mechanical or chemical means; and (3) plant seeds of preferred plant species. Crop farming traditionally entails the total replacement of native plants with generally one species of domestic plant such as wheat or corn.

Native Vegetation in the APR Region

- The rolling uplands of the APR region are dominated by mixed-grass prairie and sagebrush shrub lands. Variable soil and moisture conditions result in dozens of plant communities, each characterized by a unique combination of grass, forb and/or woody plant species.
- Riparian areas along lowland streams often support a diversity of shrubs and trees.
- 400 - 500 plant species occur in the region.

Common Commodity Management Practices Affecting Native Vegetation in the APR Region

- The most extreme commodity management practice is the conversion of native prairie to crop production, commonly wheat and alfalfa. Portions of the APR region have been converted to crop production and conversion of native prairie to cropland continues.
- Some areas are furrowed and over-seeded with preferred forage grasses. In the past, extensive areas were over-seeded with non-native crested wheat grass.
- Sagebrush is sometimes eliminated or controlled by chaining and other methods to favor the growth of grasses.
- Check dams and spreader dikes are often installed in bottom lands to irrigate pastures and hay fields, with major effects on native vegetation.
- A concern to commodity producers as well as conservationists is the invasion of noxious non-native plants such as spotted knapweed.

APR's Management Response

Soil and vegetation managed for production → *Native plant diversity and underlying processes*

Restoring native prairie, especially on previously cultivated land, is one of APR's most costly and long-term management tasks. We have begun reseeding native plants on cultivated land and removing check dams to facilitate restoration of riparian habitats. We also collaborate in controlling invasive noxious weeds. APR is working with neighbors, partners and scientists to prioritize restoration efforts. The effect of different grazing pressures on vegetation is also being monitored. Prescribed burning effects on flora are being measured on a recent burn area. When possible, we remove non-native planted species of shrubs and trees such as Russian olive.

2. Herbivory Patterns

Dennis Lingohr

Herbivory, the technical term for animals eating plants (such animals are called herbivores), is one of the most important ecological factors affecting the evolution and biodiversity of Great Plains prairies and of grasslands and savannas around the world. Herbivory is usefully divided into two types: "grazing" refers to animals eating grass and forbs (non-woody plants), and "browsing" refers to animals eating the tissue (leaves, flowers, stems) of woody plants.

Large numbers of grazers and browsers once inhabited and greatly influenced plant and animal diversity on the Great Plains. Before Euro American settlement, these included tens of millions of bison and massive numbers of other ungulates (hooved mammals) like elk, deer and pronghorn. Much smaller herbivores were also important. Of particular significance was grazing and burrowing by prairie dogs, whose colonies once covered millions of acres in North America.

Smaller yet are one of the Great Plains' most important herbivorous insects—grasshoppers—with more than 300 species across the region. Episodic outbreaks of swarms of Rocky Mountain locusts, a type of grasshopper, periodically emerged from the mountains to spread across North America's grasslands. These outbreaks surely had a massive influence on biodiversity. The last of these episodes occurred in the late 1800s. Now, for unknown reasons, the Rocky Mountain locust may be extinct.

Under natural conditions, the intensity of grazing and browsing by herbivores varies widely across the landscape. This leads to a diversity of habitats, ranging from very low vegetation or even bare ground on heavily used sites to tall and dense vegetation on seldom-used sites. Scientists often call such diversity "habitat heterogeneity." The interaction of grazers and fire further enhances variation in vegetative cover. This is important because different species of grassland birds and rodents prefer vegetation of different height and density.

Livestock production has historically focused on minimizing variation in grazing intensity. Rangeland managers sometimes refer to the idea of "take half, leave half" as a management guideline. By managing livestock to eat half and leave half of the vegetation, a uniform structure of vegetation—not too tall, not too short—is created across the landscape. Whereas nature "manages" to the extremes, traditional rangeland managers "manage to the middle," another commonly used phrase. The result is a declining number of birds, rodents and other wildlife that depend on habitat extremes.

Natural Herbivory in the APR Region

- Grazing and browsing by prairie dogs, bison, elk and pronghorn, as well as by grasshoppers and other smaller species once created a mosaic of habitats.

- Grazing patterns, historically, were strongly affected by periodic fires (see fire section).

- The habitat mosaic created by natural grazing and fire are crucial for supporting the region's diversity of grassland birds. For example, the Mountain plover relies on bare ground, McCown's longspur likes short vegetation, Chestnut-collared longspurs prefer taller vegetation, and Sprague's pipit and Bird's sparrow occur mostly in very tall vegetation.

Common Commodity Management Practices Affecting Natural Herbivory Patterns in the APR Region

- Stocking rates for livestock are established to create uniform grazing intensity across the land and from year to year.

- Rest-rotation grazing of livestock, whereby the land is fenced into grazing units and livestock are periodically moved among units to create uniform grazing intensity, is common on both private and Bureau of Land Management (BLM) lands.

- Because livestock seldom graze areas far removed from water sources, numerous stock ponds and tanks have been installed to enable livestock to uniformly graze all areas.

APR's Management Response

Uniform grazing → *Natural grazing patterns that help create habitat diversity*

The practice of uniform grazing is deeply imbedded in rangeland management and can be slow to change. Nevertheless, APR is cooperating with BLM and C.M. Russell National Wildlife Refuge to remove fences to allow bison and other ungulates to move more freely across the landscape, creating more variable grazing intensities. APR is developing a monitoring protocol with BLM to measure vegetation use and changes in plant species abundance resulting from our grazing practices.

3. Fire

Dennis Linghor

Fire has been a central factor in the evolution of grasslands around the world. Fire plays two important roles in maintaining prairie biodiversity. One role is to stop the invasion of shrubs and trees. Without fire that kills young saplings, western red cedar and other tree species can invade prairies with devastating effects on biodiversity and the productivity of these areas for livestock.

The other effect is the interaction of fire and grazing, whether by livestock or wild ungulates. When a grassland burns, especially grasslands with rank (old) growth that is not nutritious and avoided by grazers, nitrogen and other nutrients are released to enrich the soil and fuel the rapid growth of new, highly nutritious plants favored by grazers. In this way, herbivory and fire are Acts One and Two on the grassland ecosystem stage, an interactive process that noted rangeland scientist Sam Fuhlendorf termed "pyric herbivory."

Under natural conditions, this two-act play takes place across the prairie landscape each year: old growth burns, grazers eat the new growth that follows, fire strikes another site of old growth next year, and the cycle continues. The result—a shifting mosaic of habitats over millions of acres—is a cornerstone for the diversity of species found on our prairies.

Fire in the APR Region

- Before Euro American settlement, any given site is estimated to have burned an average of every 8-70 years in the APR region. Both lightning and Native Americans caused fires.

- In addition to affecting nutrient cycling and grazing patterns of wild ungulates, fire has probably historically limited the extent of sagebrush habitat (fire will kill sagebrush) and, near the Missouri Breaks and Little Rocky Mountains, limited the spread of ponderosa pine and Douglas fir into the prairie.

Common Commodity Management Practices Affecting Fire in the APR Region

- Fires have been greatly suppressed in the region since Euro American settlement, although large fires occasionally occur.

- As a result, the interaction of fire and ungulate grazing (the pyric herbivory cycle), and the habitat diversity it creates, are now gone from most of this region.

- A landowner's ability to allow patch fires to occur is greatly constrained by the fact that fires may escape to neighboring properties.

- The C.M. Russell National Wildlife Refuge is now using lightning-caused and prescribed fires to meet conservation goals.

Dennis Linghor

APR's Management Response

No or infrequent fires → *Periodic fires on the landscape*

APR believes fire should be restored to its historic ecological role in the prairie ecosystem. To that end, we are collaborating with the C.M. Russell National Wildlife Refuge, BLM and researchers to better understand the role of fire in this region and its effects on grazing patterns and biodiversity. APR manages livestock numbers to allow flexibility if natural fires reduce forage for grazing during the summer and fall. As such, APR does not view fire as a damaging event on its livestock operation.

4. Streams

Diane Hargreaves

Streams create diverse habitats and play a variety of ecological roles in the world's grasslands, particularly in the more arid grasslands of the Great Plains. In prairie uplands, where streams first form, their flow is usually intermittent. A prairie thunderstorm can turn a dry streambed into a torrent of water, but after a week or two of no rain the flow will stop and only ephemeral small pools may remain.

These small streams merge to form larger streams with continuous flows that support increasing numbers of plants, amphibians, fish, aquatic insects and other water-adapted organisms. Because prairie streams are such dynamic habitats, their inhabitants must be highly adaptable and resilient. Prairie streams are also a source of drinking water for hundreds of non-aquatic species.

Bottom-land streams and the rivers they feed into generally have moist and nutrient-rich soils because of periodic flooding. These areas often support riparian habitats of willows, cottonwoods and other shrubs and trees and harbor a unique assemblage of wildlife. The great rivers of the Great Plains—the Saskatchewan, Missouri, Platte, Arkansas and others—and the Mississippi River depend on the health of the prairie streams that feed them.

Prairie streams are often degraded by livestock trampling and by dams and other devices constructed to capture stream flows for watering livestock and irrigating nearby fields. Dams, especially for stock ponds, capture and cut off high flows that occur after heavy rains and spring snow melts, which in turn may reduce periodic downstream flooding that maintains soil moisture and deposits seeds and nutrient-rich sediments on the floodplains. Stock ponds are stepping stones for aquatic and riparian species not native to upland prairies, and they fragment prairie streams by acting as barriers to upstream and downstream movements of fish and other aquatic species. Although stock ponds offer aquatic habitat for ducks, shorebirds and other species, they are exotic habitats in upland prairies.

Finally, rapid run-off from cultivated lands can carry large loads of silt and pesticides downstream. The large dead zone in the Gulf of Mexico at the mouth of the Mississippi River is largely caused by nutrient-rich silt eroded from cultivated lands across the Mid-West and Great Plains.

These impacts on rivers and streams pose a threat to many aquatic species, as evidenced by the fact that 29 species of Great Plains fish in the United States are federally list as vulnerable, threatened or endangered.

Streams in the APR Region

- The region's streams are highly dynamic with flows that vary widely between periods of drought and torrential summer thunderstorms.

- During dry periods, ephemeral pools persist along the reaches of streams with small prairie fish and other aquatic species often found in them.

- Under natural conditions, larger streams in lowland areas were lined with riparian forests of cottonwoods, willows and other trees and shrubs, supporting a unique assemblage of wildlife such as beaver and bobcats, forest-dwelling songbirds, and hawks that use the large cottonwoods for nesting.

• Montana's prairie streams and rivers support more than 35 species of fish, far more than are found in the state's mountain streams and rivers.

Common Commodity Management Practices Affecting Streams in the APR Region

• Numerous stock ponds have been constructed to provide readily available water for livestock at a density of 1-2 or more per square mile in the APR region.

• Most of the larger streams in the low-lying areas of the APR region have had small dams, often called check dams, constructed to divert water for irrigation of hay meadows and crops. Spreader dikes are commonly used to spread irrigation waters across the land. The result is that nearly all streams that flow through the C.M. Russell Refuge and into the Missouri River have been seriously degraded.

• Domestic livestock, particularly cattle, are more dependent on and stay near water sources more than wild ungulates. Livestock trampling of stream banks and defecation in streams cause substantial habitat degradation.

APR's Management Response

Dammed and degraded streams → *Natural water flow and assoc. species*

Several water impoundments have been altered on the APR and different approaches to restoring riparian vegetation are being tested. The removal of stock ponds requires considerable research to better understand potential impacts on downstream habitats (for example, large loads of silt would be released) and on wildlife that may use them because natural wetlands have been lost or fencing prevents access to other sources of water. Stock pond dams eventually deteriorate on their own, perhaps making direct intervention unnecessary.

APR will continue to coordinate with local, state and federal agencies to design restoration projects that improve natural stream flows and fish passage. This may include modifying current impoundment structures to develop a system that allows for management of water closer to natural stream levels.

There are numerous artificial diversions designed to spread stream water across fields for flood irrigation. When appropriate, APR chooses not to flood irrigate to allow for increased stream flow.

5. Temporal Ecological Variability

Dennis Linghor

Temporal ecological variability" is a broad measure of how much change, or variation, occurs day-to-day, season-to-season, year-to-year and decade-to-decade. Day-to-day changes can be abrupt, from desiccating 100-degree temperatures and high winds one day to torrential rain the next, the latter recharging intermittent streams and stimulating the rapid growth of grasses and next bloom of prairie flowers. Seasonally, temperature differences on Montana's prairies may vary as much as 130 degrees; winter temperatures may dip to 30 below with winter winds driving the chill factor much lower. Occasional deep snows add to the seasonal challenges for wildlife. Droughts may last decades.

Wide climatic fluctuations result in grasslands displaying more year-to-year variability in plant growth and productivity than any other ecosystem in North America. These extremes interact with fire and grazing to create large ecological variations over time at the local scale of a few acres. At larger scales of thousands and millions of acres, they create the shifting mosaic of habitats crucial for prairie biodiversity.

Life on the prairie is adapted to these boom-and-bust conditions. Roots of prairie grasses penetrate 6-10 feet deep for a reason—to find moisture during droughts. (The compass plant goes deeper—10-15 feet!)

Prairie birds migrate thousands of miles south each fall to avoid winter scarcity and return each spring to lush growth to raise their young. Small mammals hibernate and bison reduce their metabolic rate 20-25% during winter as a way to conserve energy and survive forage-poor conditions.

Such extremes are generally unfavorable to livestock and crop production. Consequently, in grasslands around the world, humans have sought ways to modulate the ups and downs of precipitation and streams flows, of temperatures, and of the resulting productivity of crops and forage plants.

Temporal Ecological Variability in the APR Region

• The APR region experiences daily, seasonal and annual variations in weather, resulting in ecological changes as extreme as perhaps any grassland region on Earth. Fifty-degree day-to-day and 130-degree summer-to-winter temperature swings are not unusual. Precipitation is highly variable. Winter snow and ice storms cap vegetation and create harsh conditions for grazing animals and other wildlife.

• Plants and animals in the region exhibit the full range of boom-and-bust adaptations, including deep root systems, rapid plant growth after a rain, hibernation and long-distance migration. The plains spadefoot toad exemplifies this. Like the roots of prairie grasses, they go deep. This two-inch, round-bodied toad possesses a digging spur (the spade) on each back foot, which they use to burrow backwards up to 2-3 feet deep into the soil until they hit moisture. They spend most of their life there in aestivation, a period of dormancy similar to hibernation, during dry periods. After a heavy rain, however, they emerge in the evening and exhibit what scientists call "explosive breeding" as males and females converge in rain-fed shallow pools. By morning the adults may be gone, having buried themselves again, perhaps for a year or more, until the next rain. Boom-and-bust environments create boom-and-bust organisms.

Common Commodity Management Practices Affecting Temporal Ecological Variability in the APR Region

• Commodity production in the APR region aims to lessen natural fluctuations, the ebbs and flows, of the prairie environment and prairie life in various ways, many of which are described under the other nine ecological conditions.

• Livestock stocking rates, rest-rotation grazing, fire suppression, irrigated pastures and croplands, and production of hay for winter feed are all methods to reduce or eliminate large changes, both abrupt and long term, in the productivity and availability of commercially important plants.

• Seasonal variation in water availability for both forage and crop production and for livestock drinking is commonly managed through construction of stock dams, water tanks, check dams and spreader dikes for irrigation.

• Cattle, sheep and most other livestock are much less tolerant of deep winter snows and wide swings in temperature than native ungulates.Consequently, barns, shelterbelts and other structures are constructed to protect livestock from weather extremes.These structures harbor, in larger numbers than would occur under natural conditions, both predators (e.g., raptors, crows, raccoons) that prey on prairie birds and cowbirds that parasitize prairie bird nests.

APR's Management Response

Management that dampens effects of weather extremes → *Restoring the role of extreme temperature & moisture flux*

APR aims to restore natural environmental fluctuations that characterize life in the prairie ecosystem. As described elsewhere in this report, this largely involves removing the various methods such as irrigation systems and rest-rotation grazing that are employed by commodity management to modulate fluctuations. APR intentionally manages livestock numbers, both bison and leased cattle, to allow for natural variation in forage and water. This means not having to sell off animals during drought or drastically increasing stocking rates during good forage years. We also favor native vegetation that is adapted to this environment, thus not planting crops that require irrigation.

6. Herbivorous Mammals

Diane Hargreaves

Herbivorous mammals, especially large ones, are icons of grasslands around the world, from wild asses of the Mongolian Steppe and wildebeest and elephants of African savannas, to kangaroos of Australia's grasslands and guanaco of the Patagonian steppe of Argentina and Chile. In the Great Plains, bison, the largest land mammal of the Americas, occupy that iconic position.

These large herbivores receive considerable attention by conservationists and the public because they are highly charismatic and interesting to watch or hunt. They also deserve attention because of their ecological role in the middle of the grassland food pyramid. Below them on the pyramid are the plants they consume. Above are the big predators that eat them and a diversity of scavengers and decomposers that feast on what the predators leave behind. Remove these large herbivores and a very different ecosystem emerges with different plants and diminished large predators.

The large herbivorous mammals of the Great Plains, including the APR region, are bison, elk, pronghorn, bighorn sheep, mule deer and white-tailed deer. Each occupies a particular ecological niche. For example, bison feed almost exclusively on grass and sedge, pronghorn eat mostly forbs and shrubs, and elk have an eclectic diet of grasses, forbs and woody plants. They also have different habitat preferences. Bison and pronghorn prefer open grasslands, elk and mule deer occupy wooded areas as well as grasslands, white-tailed deer prefer riparian forests, and bighorn sheep are adapted to rugged terrains with rocky slopes and ledges where they can evade predators. Besides grazing, bison exhibit other habitat-altering behaviors. Their horn rubbing can girdle a tree and may have been a factor limiting the growth of trees in the Great Plains. Bison wallowing (repeated rolling on their backs for dust baths in the same spot) historically created millions of shallow depressions that captured snow melt and rain water, resulting in mini-wetlands across the landscape.

Not all iconic herbivores of the Great Plains are big. The black-tailed prairie dog is a herbivorous mammal of enormous ecological importance across the region. Historically, prairie dog towns (colonies) often extended for tens of miles, each occupied by thousands of prairie dogs. The very short vegetation and bare ground that result from their eating and clipping of plants in and around the colony creates habitat preferred by some prairie birds. Plant growth around colonies is often more nutritious and thus heavily grazed by ungulates. Their extensive burrowing churns the soil and provides subterranean habitat for burrowing owls, snakes and other species. They are prey to a host of prairie predators, from golden eagles and ferruginous hawks to badgers and coyotes. And of particular importance, the endangered black-footed ferret is almost exclusively dependent on prairie dogs for food and for burrows, which serve as den sites.

The dietary relationships between livestock and wild herbivorous mammals are complex. When animal numbers are low and grazing intensity light or moderate, very little or no competition for forage may occur. In fact, it can be what scientists call "facilitative." Elk may browse grassland shrubs, which favors growth of underlying grasses, thereby increasing food for cattle. During periods of food stress, such as during a drought, the otherwise relatively distinct diets of different species can begin to break down as animals seek out whatever plant growth is available. Competition for forage between livestock and wild herbivores can then be intense.

Generally, because livestock production benefits from abundant grass, large numbers of wild herbivores can reduce ranch profitability. Landowners are also often concerned about wild ungulates feeding on grain crops such as wheat. Consequently, large numbers of wild herbivores are often not well tolerated.

Herbivorous Mammals in the APR Region

- Bison and elk were extirpated by hunting from the region by the late 1800s. Bighorn sheep disappeared by the early 1900s, possibly due to both over hunting and diseases such as anthrax brought in by domestic sheep. Pronghorn numbers also severely declined during this period.

- Elk and bighorn sheep were reintroduced in the Missouri Breaks beginning in the 1940s and 1950s. APR introduced its bison herd in 2005.Pronghorn have made a comeback in the APR and across the Great Plains.

Healthy populations of mule deer and white-tailed deer remain in the region.

• Prairie dog colonies occur in several places in the APR region, but their population is a small fraction of what it was before Euro-American settlement. Because the C.M. Russell National Wildlife Refuge (CMR) is one of the few sites in the Great Plains for recovery of the highly endangered black-footed ferret, healthy populations of prairie dogs, the primary food of ferrets, is particularly important.

Common Commodity Management Practices Affecting Herbivorous Mammals in the APR Region

• Most commodity producers are opposed to bison reintroduction in the region, including opposition to the concept of establishing a legally "wild" herd. Concerns include disease transmission between bison and cattle, bison trampling of fences, human safety and forage competition with cattle.

• Most of the region's several thousand elk are found in the forested breaks and flood plains of the C.M. Russell Refuge, but herds frequently move onto the prairie to feed on APR and ranch lands. Elk are tolerated in the region but at reduced numbers because of concerns about forage competition and destruction of fences.

• Pronghorn occasionally feed on wheat and alfalfa, have little dietary overlap with cattle, and are generally well tolerated by the agricultural community.

• Prairie dogs are not well tolerated by commodity producers because of concerns about forage competition. As such, they are not found or only occur in low numbers on ranchlands. Cropland is not suitable prairie dog habitat.

• Roughly 1,000 bighorn sheep across several herds inhabit the rugged breaks habitats of the C.M. Russell Refuge and Upper Missouri River Breaks National Monument. Though bighorn numbers are sometimes controlled when they feed on private grain fields, a major goal in controlling their distribution and population is to avoid transmission of serious diseases from domestic sheep to bighorns.

• White-tailed deer prefer riparian areas while mule deer are found in the more rugged and rolling uplands of the APR region. Ranchers and farmers are interested in keeping their numbers low because of potential crop damage and competition for forage.

APR's Management Response

Livestock as the most common mammalian herbivore → *Natural populations of native grazers*

APR's goal is to restore populations of all native herbivorous mammals. Our focus is now on growing the bison herd that we first introduced in 2005 to several thousand animals as well as on greatly expanding the distribution and population of prairie dogs. Over time, APR will coordinate with Montana Fish Wildlife & Parks to allow for increased numbers of these species and other herbivores by expanding the acres of good habitat. We intend to work with neighbors to reduce wildlife conflicts and increase tolerance for mammalian herbivores on their land.

Recently, we have partnered with World Wildlife Fund and the C.M. Russell Refuge to mitigate the effects of sylvatic plague on prairie dog colonies. We have several prairie dog colonies included in a vaccine trial for plague. Other efforts to help prairie dog town expansion include mowing around the edges of current colonies and using prescribed fire. Many of these efforts are still in the experimental stage, but as results become clear management actions will be expanded.

Dennis Linghor

7. Fate of Ungulate Production

Dennis Linghor

The large body size—or "biomass"—of ungulates gives them two important roles in the middle of the food web. First, large prey sustain large predators. Historically, the three large predators (sometimes called "apex predators") of western North America's prairies and other grasslands were the wolf, grizzly bear and cougar. Wolves, which, unlike the other two species, hunt in packs and can pursue prey for long distances, are mostly elk and bison hunters. Grizzly bears may opportunistically prey on any of the large ungulates, and in Yellowstone National Park they frequently chase wolves off of an elk or bison carcass.

Cougars ambush prey, which is particularly suited to hunting deer and bighorn sheep occupying wooded or rugged terrain. The coyote, though much smaller than the big three, is also an important predator and scavenger of ungulates. It is particularly adept at finding pronghorn fawns hidden in the grass during their first 3-4 weeks of life. Once a pronghorn reaches several weeks of age, however, they can readily outrun any predator—except golden eagles.

Black bears and bobcats are other predators that sometimes prey on North America's grassland ungulates. Finally, ungulate carcasses are food for many species of smaller scavengers such as ravens, crows and black-billed magpies.

Much less understood and under appreciated is the role of ungulate carcasses in nutrient cycling, particularly in creating nutrient "hot spots." The decomposing carcass of a 500-700-pound elk or a 1,000-2,000-pound bison, even if partially consumed by predators and scavengers, is loaded with nitrogen, phosphorous and other nutrients. The transformation from fetid bison carcass to fragrant prairie flower plays out slowly over months and years. First, the shadow of the carcass itself and the copious fluids released as it decomposes kill several square feet of underlying vegetation. As the carcass disappears the nutrients left behind support the growth of plants, often forbs, which are distinct from those of the surrounding prairie. Some of the most productive plant growth is in a nutrient-rich—but not too rich—ring that surrounds the site. This lush growth, in turn, attracts bison, pronghorn and other grazers whose urine and dung adds to and expands the nutrient-rich zone of plant growth.

Over time, vegetation on the site will again resemble that of the surrounding area, but by then new carcasses elsewhere will begin the cycle again. Thus, under natural conditions, one can envision this process adding yet another dimension to the shifting mosaic

Native Ungulates of the APR Region

- As described under herbivorous mammals, APR is within the range of all ungulates found in the Great Plains. Historically, when populations were at more natural levels, their carcasses were important contributors to prairie biodiversity.

- Today, bison and elk in open prairie habitat (as opposed to the Missouri River breaks and flood plain) and bighorn sheep are rare compared to pre-settlement numbers. Pronghorn populations are probably somewhat lower and mule deer and white-tailed deer populations may be within pre-settlement ranges.

Common Commodity Management Practices Affecting the Fate of Ungulate Production in the APR Region

- Understandably, a livestock producer's goal is to sell 100% of livestock production (except for animals butchered for the family's freezer), which means nearly all livestock biomass is eventually removed from the land. Livestock do occasionally die on the land, but how many die and are left on the land in the APR region is unknown. The overall effect, however, is that compared to conditions when wild ungulates and big predators inhabited this region, few nutrients from livestock carcasses are being recycled back through predators, scavengers and decomposers into the ecosystem.

- Sport hunting of elk, pronghorn, deer and bighorn sheep in the region also results is a large share of the wild ungulate biomass being removed from the land every year.

APR's Management Response

Most livestock being removed → *Wild ungulates consumed and decomposed*

APR's goal is to have most ungulate biomass recycled through the prairie's food web and to restore the effect that large carcasses probably had on prairie biodiversity. More research is required to better elucidate these effects. We need to be cautious regarding the potential for large numbers of carcasses fueling an increase in the coyote population (especially in the absence of wolves which kill and displace coyotes), with inadvertent consequences for species that coyotes kill (e.g., pronghorn and swift fox).

Human hunting of ungulates will continue to be an important component of the Reserve. APR intends to discuss these ideas with neighbors. While we may be accepting of increased ungulate carcasses on our land, neighboring producers do not desire this on their own properties for concern of attracting predators.

8. Predators

Teddy Llovet

Often called apex predators because they occupy the top of the food pyramid, big predators can strongly influence the structure and biodiversity of ecosystems through what scientists call "trophic cascades." Each level in a food pyramid—plants at the base, herbivores in the middle and predators at the top—is called a "trophic level." A trophic cascade occurs if, when big predators are removed from an ecosystem, the population of ungulates they prey on increases which, in turn, causes the decline and disappearance of plants that ungulates feed on.

Recent research by Robert Beschta and William Ripple in five western national parks is instructive regarding possible trophic cascades in the Great Plains. In some parks, eradication of wolves resulted in much larger elk populations, and in others the reduction of cougars led to high mule deer populations. More complex was Wind Cave National Park in South Dakota, where the loss of wolves, cougars, black bears and grizzly bears probably resulted in population increases of mule deer, elk and bison.

In each park, the increased browsing pressure caused by the surge in ungulate populations quickly led to a decline in young trees, such as aspen, cottonwood and willow. This decline can have various cascading effects on other species (e.g., loss of tree-nesting song birds and of beaver that use trees to build dams) and ecosystem structure and processes (e.g., forests becomes grasslands and beaver ponds disappear).

Reintroduction of wolves to Yellowstone National Park in 1995 demonstrates the reversibility of the trophic cascade effect. The return of wolves both reduced the elk population and changed elk browsing behavior. This resulted in reduced browsing by elk on young aspen and willows in open areas along grassland streams. Quickly, large aspen and willow stands have become reestablished along streams which, it appears, facilitated the return of beaver and resulting new beaver ponds.

The return of wolves to Yellowstone yielded another trophic cascade result. Before wolf reintroduction, pronghorn populations in the park were in decline because of the large number of coyotes that are very skilled at preying on pronghorn fawns. Wolves chase and kill coyotes, and so as the wolf population grew the coyote population declined. The resulting increase in fawn survival has enabled the pronghorn population in the park to grow.

Before Euro American settlement, wolves, grizzly bears and cougars, as so vividly described in the journals of Lewis and Clark and other early explorers, were common on the Great Plains. Wolves probably followed bison and elk herds across the entire region, while grizzly bears and cougars were primarily found in riverine areas, badlands and isolated mountain ranges such as the Black Hills. All were hunted, trapped and poisoned to extinction in the Great Plains by the early 1900s. Only the cougar has recolonized parts of its former range. Although wolves and grizzly bears occasionally venture out onto the prairie from the Rocky Mountain front, no permanent

populations have become reestablished.

A fourth apex predator of the Great Plains, however, never disappeared. Humans have been a top predator in the Great Plains for millennia.

Hunting and competition for food by early human inhabitants of the Great Plains—and North America generally—probably caused the extinction of many large mammals, from the giant cheetah and saber toothed tiger to the giant bison and Columbian mammoth. However, for several thousand years before Euro American colonization, humans, wolves, grizzly bears and cougars had largely coexisted with the current ungulates of the Great Plains.

Big Predators of the APR Region

• The vast bison and elk herds that once inhabited the APR region almost certainly supported many packs of wolves. Lone wolves are occasionally reported to wonder through the region now, but the closest populations are in the mountains of Glacier National Park and the Bob Marshall Wilderness Area about 150 miles west of the APR and, much closer, in the Little Belt Mountains 80 miles to the southwest. The population of several thousand elk in the region—and larger numbers of bison in the future—could probably support several wolf packs.

• Lewis and Clark reported multiple encounters with grizzly bears in the APR region. Based on the explorers' accounts, researchers Andrea Laliberte and William Ripple roughly estimate that grizzly bear density along their route through the prairies was 8 animals per 100 square miles, more than 3 times the current density in Yellowstone National Park. The nearest population of grizzly bears today is in the Glacier National Park and Bob Marshall Wilderness regions, although recently bears from this population have been venturing as far as 50-60 miles east onto the prairie.

• Cougars recolonized the APR region several years ago by moving east out of the Rocky Mountains. They primarily inhabit the rugged terrain of the Missouri River Breaks and the island mountains such as the Little Rockies and Bear's Paw. The state of Montana currently allows hunting of cougars in the region. Cougars are not considered a nuisance for livestock owners or a concern for human safety in the region.

• Native Americans were top predators in the APR region for thousands of years. The most vivid signs of this are the region's buffalo jumps, where layers of bison bones more than 20 feet deep and other hunting evidence date back more than 2,000 years. Today, people of diverse ancestries continue to hunt the region's wildlife.

Common Commodity Management Practices Affecting Big Predators in the APR Region

• Local landowners and many elk hunters in Montana have resisted reintroduction of wolves and expansion of their range because of concerns about livestock depredation and effects on elk populations. Restoration of wolves in the APR region, even if through natural recolonization, would surely be strongly resisted.

• Because of concerns about livestock depredation and human safety, grizzly bear restoration would also likely be strongly resisted by commodity producers.

• Ranchers and the broader community generally support cougar conservation and have shown tolerance to the natural return of cougar in the APR region.

• Landowners in the region, including APR, the C.M. Russell Refuge, BLM, state trust lands and private ranchers, generally allow hunting on their lands.

APR's Management Response

Few big predators → *Natural populations of big predators*

Although APR supports the return of large predators, the authority for any restoration work falls under the jurisdiction of Montana Fish Wildlife and Parts (MTFWP)and/or U.S. Fish and Wildlife Service (USFWS). Decisions regarding reintroduction of wolves or grizzlies in the region will need to be made by these agencies with broad public input.

APR is cooperating with these agencies and various partners in conserving the cougar population of the region. Currently the best way for APR to support big predator populations is to provide large areas of high quality habitat and the prey base of large ungulates.

9. Habitat Contiguity

Gib Myers

Habitat contiguity is a measure of habitat intactness, of the degree to which natural habitats are uninterrupted by artificial features that humans have installed which impede animal movements or in other ways break up the habitat. Scientists generally refer to this breakup as "habitat fragmentation." Cultivated land and fences are the most obvious causes of habitat fragmentation; roads and railroads can also be major movement barriers and causes of mortality. The contiguity of grassland habitats is particularly important because of the wide-ranging movements and migration patterns of ungulates that graze them. Whether wildebeest on the plains of east Africa or bison and pronghorn in the Great Plains, many grassland ungulates must move hundreds of miles seasonally to find food.

Among Great Plains ungulates, fencing is particularly problematic for pronghorn. Pronghorn are built for speed, not for jumping. Consequently, pronghorn movements are severely impeded by livestock fencing, and pronghorn often get hung up and die trying to cross fences. Bird movements are also affected by fencing. Fence collisions of the low-flying lesser prairie-chickens in the southern Great Plains and greater sage-grouse in the northern Great Plains cause significant mortality of these two imperiled species.

Impeded movements are not the only fragmentation problem. Many prairie birds avoid nesting near vertical structures such as fences, buildings, windbreaks and trees along stock ponds—and for two good reasons. First, vertical structures provide habitat and perches for both predatory birds such as the northern harrier and short-eared owl, and for terrestrial predators such as the raccoon.

Second, a common nest parasite of small grassland birds, the brown-headed cowbird, uses vertical perches to help it find nests in which it can lay its eggs so that the parasitized birds—meadowlarks, bobolinks and many other species—will incubate and raise the cowbird young, which generally kick out and kill the host birds' young. The end result is that grassland birds raise fewer young near vertical structures and, in response, over evolutionary time have evolved instincts to avoid nesting near them.

Cultivated land fragments and reduces the area of intact habitat with several negative consequences for prairie biodiversity. We review this under the next section on size of management units.

Habitat Contiguity in the APR Region

- Pronghorn of the APR region undertake annual north-south migrations of several hundred miles between Montana in the winter and Alberta and Saskatchewan in the summer. Large, unbroken expanses of prairie are therefore crucial for healthy pronghorn populations.

- Bison, elk and bighorn sheep, among many other species, also thrive best under conditions of large, contiguous habitat.

- As explained under Herbivory Patterns, allowing bison, elk and pronghorn to roam and feed over large areas of tens of thousands of acres without fencing or other barriers is important for creating variation in grazing intensity, resulting in habitat heterogeneity.

- For greater sage-grouse, a candidate species for listing under the Endangered Species Act, fence collisions and man-made vertical perches for predatory birds are important management concerns.

• The APR region is home to many small grassland birds, such as Baird's sparrow, chestnut-collared longspur and Sprague's pipit, that have been undergoing significant population declines in recent decades. Nest predation and nest parasitism are important causes of nestling mortality for these birds, and securing large expanses of prairie free of artificial vertical structures is important.

Common Commodity Management Practices Affecting Habitat Contiguity in the APR Region

• Substantial existing cropland and ongoing conversion of prairie to cropland both break up and reduce the total area of prairie habitat in the region.

• Extensive fencing is used to manage livestock on all lands in the APR region—private, BLM, state and the C. M. Russell National Wildlife Refuge.

• Collisions with vehicles and trains are a common cause of mortality for wild ungulates and other wildlife.

• In addition to fence posts, tree plantings for windbreaks, trees at the edge of stock ponds, ranch buildings and utility service poles are vertical structures and habitats for both avian and terrestrial nest predators of grassland birds as well as for nest parasitism by brown-headed cowbirds.

APR's Management Response

Fences & structures that divide habitats → *Vast landscapes undivided by structures*

APR is committed to reducing fragmentation and reversing the loss of prairie habitat to cultivation. We are removing fences and outbuildings from our properties and burying services lines where possible. Where fence removal is not possible, we convert fences to wildlife friendly construction that allows easier and safer movement of wildlife. We have entered into conservation easements in some areas to consolidate building sites thoughtfully for future development.

10. Size of Management Units

This category addresses two interrelated factors: (1) the area of intact habitat and (2) how management of the area is divided among landowners.

(1) Area of Intact Habitat

Many grassland species and ecological processes require big areas—thousands to hundreds of thousands to millions of acres—to survive and function. Prairie fires, bison grazing and nutrient flow through a stream are among the many processes that work best at large scales. For many grassland species, bigger is better. Small grassland birds—sparrows, longspurs, pipits and others—nest more frequently and with higher success in habitat patches of more than 1,000 acres. Greater sage-grouse require thousands of acres of mostly sage-brush habitat with very little nearby human infrastructure or activity. Nesting pairs of golden eagles often protect territories of 5,000-20,000 acres or more. We know little about wolf pack territory size on the prairie, but it's likely measured in tens of thousands of acres.

Area requirements for many species are often determined by how much habitat is needed to support a population large enough to avoid inbreeding and other factors that can erode genetic health. Biologists estimate that bison, for example, should have a population of 2,000 or more to maintain long-term genetic health. In the drier regions of the Great Plains, 100,000-200,000 acres may be required to support a population of this size.

Two other points are important regarding area requirements of species. First is "habitat connectivity." If two areas of habitat are connected via a corridor of habitat that animals can safely move through, this can be important for exchanging genes between the populations of those two areas. For example, because wolves can move hundreds of miles within days or weeks, the genetic health of a small population living in a small area may be maintained because of genes brought in by the occasional new immigrant wolf.

Secondly, no prairie conservation area, regardless of its size, can stand alone as an island. Many species—migratory birds, mammals and insects—depend on distant, intact habitats.

In the Great Plains, these are usually species that annually migrate to overwinter in habitats of the southern-most U.S. and Latin America.

(2) How Habitat is Divided Among Landowners

This factor is important because managing for the large-scale needs of prairie conservation can be complicated and difficult if land is divided among numerous landowners with different land management goals. Biodiversity does best when management for biodiversity is seamless across the land.

Multiple landowners require extraordinary coordination to achieve a unified approach to land management. Landowners must agree on goals and management approaches, on budgeting and sharing of management costs, and on how revenues (e.g., from hunting and tourism fees) and risks are fairly divided among them. Ongoing coordination and considerable good will are required to follow through on these plans. Fewer landowners managing large land areas can make this task easier.

Size of Management Units in the APR Region

- The APR region encompasses several million acres of largely intact habitat, offering exceptional opportunities for restoring and conserving species and ecological processes with large-scale needs.

- Each stream system/watershed of the APR region generally covers several hundred thousand acres.

- Large raptors and large mammals (both predators and ungulates) of the region require large expanses of intact habitat to achieve viable population sizes and to fulfill their ecological roles in the prairie ecosystem.

- An outstanding opportunity for large-scale conservation of diverse habitats is presented by the cross-section of habitats in the APR region—Missouri River and its floodplain, rugged Missouri River breaks, rolling upland prairies, pine forests of the Little Rockies, and numerous wetlands and streams.

Common Commodity Management Practices Affecting Size of Management Units in the APR Region

- Six main types of land ownership exist: individuals (includes partnerships and corporations), tribal, state school trust lands, Bureau of Land Management (BLM), US Fish & Wildlife Service (USFWS) and non-profit. Each has different land management goals and approaches. Most include livestock management as a goal. Dry land farming is also important for individual and state school trust lands. Depending on the species, Montana Fish Wildlife and Parks (MTFWP) and USFWS have management responsibilities that overlie property ownership.

- BLM, with more than 3 million acres in the APR region, is the largest landowner. BLM lands are highly interspersed with individual, state and nonprofit lands. BLM management goals combine livestock grazing and biodiversity conservation.

- USFWS manages the 1.1-million-acre C.M. Russell National Wildlife Refuge (CMR) and 15,551-acre Bowdoin Refuge, for which biodiversity conservation is the primary management goal. Roughly two-thirds of the CMR is leased for livestock grazing with grazing managed to help meet conservation goals.

- Most land of the 675,000-acre Fort Belknap Indian Reservation is individually allotted (and thus best considered as individual ownership), but 211,000 acres are tribally owned. Cattle ranching and dryland farming, as well as wildlife conservation that includes a bison herd, are primary activities on tribal lands.

- State lands are highly dispersed with an average of two, 640-acre parcels in each township. These lands are leased for ranching and farming to generate revenues for schools.

- APR owns 65,003 acres consisting of seven separate management units; it also leases 240,054 acres of BLM and state lands. Biodiversity conservation is the primary goal of both organizations but with different management approaches.

APR's Management Response

Many small managed areas → *Large areas with coordinated land management*

APR increases the size of management units by purchasing land, acquiring leases and exchanging property.

Summary

Prairie wildlife is resilient, an evolutionary adaptation to the boom-and-bust conditions of life on the Great Plains. This is why we've adopted a "build it and they will come" philosophy to managing American Prairie Reserve (APR) lands. Prairie plants and animals will bounce back to their former abundance if we restore the ecological conditions—the large and dynamic playing field—to which they are so well adapted.

To implement these management changes, we must pay attention to two major tasks. First, we need to clarify the criteria by which we will measure and monitor management changes and their effects on the ten ecological conditions. Our 7-point scale for scoring management changes must combine objectivity with user friendliness so that different users give similar scores. Some measures, such as keeping count of the number of dams removed from a stream, will be relatively simple. Others, such as changes in grazing patterns, will be more complicated to evaluate.

Secondly, we need to assess how plants, animals and ecological processes respond to these changes. Are our assumptions about the importance of the ten ecological conditions correct? What adjustments in our thinking are needed? For example, how will downstream habitats and fish populations change after dam removal? Will we see a marked increase in habitat heterogeneity and populations of rare prairie birds when we change from rest-rotation cattle grazing without fire to large-scale bison grazing with fire?

These are challenging and important questions for our Reserve managers and collaborating scientists. There is much to learn as we move ahead. As APR managers, we need to be as adaptive and resilient as prairie wildlife.

One important final note: our goal is for this work to extend far beyond the boundaries of APR. We look forward to sharing our experience and working with landowners in the APR region who may be interested, for example, in creating more biodiversity-friendly ranching practices. More broadly, we look forward to sharing our management experiences, as we learn from both our successes and mistakes, with others around the world involved in large-scale ecosystem conservation.

AMERICAN PRAIRIE RESERVE

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